# 1. INTRODUCTION

## 1.1 PURPOSE AND NEED FOR ACTION

The U.S. Department of Energy (DOE) proposes to consent to a proposal by the Puerto Rico Electric Power Authority (PREPA) to allow public access to the Boiling Nuclear Superheat (BONUS) reactor building located near Rincón, Puerto Rico for use as a museum. PREPA, the owner of the BONUS facility, has determined that the historical significance of this facility, as one of only two reactors of this design ever constructed in the world, warrants preservation in a museum, and that this museum would provide economic benefits to the local community through increased tourism. Therefore, PREPA is proposing development of the BONUS facility as a museum.

In 1960, the Atomic Energy Commission (AEC, predecessor to DOE) entered into a contract with the Puerto Rico Water Resources Authority (PRWRA, predecessor to PREPA) for the construction and operation of the BONUS reactor. The BONUS reactor was constructed from 1960 to 1962 through a combined effort of the AEC and PRWRA. The BONUS reactor was one of only two boiling water superheat reactors ever developed in the world, and was established as a research project to evaluate the effectiveness of this reactor design. The reactor operated from 1962 to 1968, when operations were discontinued. The AEC and PRWRA decided to decommission the BONUS reactor. Decommissioning activities included (1) removal of all special nuclear materials (e.g., nuclear fuel) and certain highly activated components such as control rods and shims from the reactor and the disposal of such materials and equipment on the United States (U.S.) mainland, (2) in-place entombment of the pressure vessel and associated internal components within a three-story-tall concrete monolith within the dome-shaped reactor building, and (3) decontamination of contaminated systems located outside of the pressure vessel that were left in place. These activities were completed in 1970.

The BONUS facility is located on the westernmost part of Puerto Rico, near the city of Rincón (Figure 1.a). The site is located on a point (Punta Higuera, Figure 1.b) near the El Faro lighthouse. The facility is approximately 2 hectares (5 acres) and is completely surrounded by a fence (Figure 2). The site is currently owned and controlled by PREPA. The BONUS site includes the dome-shaped reactor building containing the decommissioned reactor systems entombed within a concrete monolith, and outside support facilities. The reactor building has three general levels: the basement, reactor floor (main level), and the mezzanine (Figure 3). Residual radioactive material is present in some areas of the reactor building, including portions of the main level, which has been proposed for public access. Physical and administrative controls have been implemented in these areas to protect workers and the public (i.e., areas with residual radioactive

Figure 1.a  Map of Puerto Rico

Figure 1.b  Location of the BONUS Facility

Figure 2.  Photograph of the BONUS Reactor Building Site

Basement Level
Figure 3. BONUS Facility Floorplan

materials have been isolated or shielded to protect site visitors and workers). Radiological monitoring and surveillance has continued at the facility, although the potential for radiological exposure is considered to be low.

While PREPA owns the BONUS facility, DOE retains ownership of the residual radioactive materials. DOE is responsible for providing radiological oversight, including an annual radiological survey of the facility. This Environmental Assessment (EA) has been prepared to evaluate authorizing PREPA to allow public access to the BONUS facility for use as a museum.

Factors that support the need for DOE action include the following:

- PREPA has proposed the development of the BONUS facility as a museum that would be open to the general public. This facility is one of only two reactors of this design ever built.

- DOE retains ownership of the radioactive materials, and must ensure that the proposed action would not result in unacceptable radiation exposures.

Evaluation during the internal reviews led to the conclusion that the following factors are present and of concern to the public:

- Residual radioactivity remaining in the BONUS reactor building; and

- Stability of the concrete monolith inside the domed BONUS reactor building during seismic events and hurricanes.

Reasonable alternatives to the proposed action which have been considered include:

(1) No Action (i.e., continued monitoring and surveillance of the BONUS facility without allowing public access to the facility); and

(2) authorizing public access to the facility for use as a museum only after additional decontamination to remove residual radioactivity above guidelines.

Additional alternatives considered but not evaluated in detail include the removal and disposal of the concrete monolith, including shipment to an off-site disposal facility, and modification of the BONUS facility to enhance the structural stability of the reactor building and monolith structure.

## 1.2 OPERATIONAL AND DECOMMISSIONING HISTORY

The BONUS facility was developed as a prototype nuclear power plant to investigate the technical and economic feasibility of the integral boiling-superheating concept. In this design, saturated steam is produced in one portion of the reactor core and this steam is superheated in another portion of the same core, and the superheated steam is used in a direct cycle to drive the turbine-generator. The facility was designed to be large enough to evaluate all the major features of this design in a realistic manner without encountering the high construction and operating costs associated with a large plant. Steam conditions were designed to match the inlet requirements of a standard 17.3 MW(e) turbine-generator for a fossil-fueled plant. (West and Fragoso, 1966)

The BONUS facility was constructed under the joint sponsorship of the AEC and the PRWRA. Startup and initial operations were performed by Combustion Engineering, Inc., and PRWRA had responsibility for long-term operation.

Construction of the facility occurred from 1960 to 1962. The BONUS reactor first went critical on April 13, 1964. The reactor underwent a series of criticality tests, and then was operated experimentally at various power levels, first as a boiler and later as an integral boiler-superheater. Full-power (50 MWt), full-temperature (900 °F steam) operation was achieved in September 1965, and tests demonstrated satisfactory operation at 10% over-power in November 1965. (West and Fragoso, 1966)

The boiling portion of the BONUS reactor contained 64 fuel assemblies at the center of the core. Each assembly contained 32 fuel rods in a 6 x 6 square array with the 4 central rods omitted. The superheating portion of the reactor consisted of four rectangular sections, one section along each side of the boiling zone. Each superheater section contained eight superheater assemblies, with each assembly containing 32 fuel rods. At normal full-power conditions, the boiling section produced 37 MWt of heat and generated saturated steam at a pressure of 985 psi. The superheater section produced 13 MWt of heat. In making four passes through the superheater assemblies the steam was heated to 900 °F. (West and Fragoso, 1966)

The active height of the core was 4.5 ft. Sintered $U0_2$ pellets were used in the fuel rods, with a Uranium-235 content of 2.4% in the boiler section and 3.25% in the superheater sections. The fuel-handling equipment consisted of a lead-shielded coffin mounted on a steel carriage which moved on rails between the reactor and the fuel storage pool. A rotating shield provided a port directly over any desired core location. (West and Fragoso, 1966)

Operation of the BONUS facility was terminated in June 1968, and decommissioning of the facility was conducted from 1968 to 1970. During decommissioning of the facility, all special nuclear materials (fuel) and certain highly activated components (e.g., control rods and shims) were removed, all piping systems were flushed, the reactor vessel and associated internal components within the biological shield were entombed in concrete and grout, and systems external to the entombment were decontaminated (PRWRA 1970). The piping for some systems was cut off at the concrete floor and grouted in place. General decontamination of the facility was performed, with the goal of meeting unrestricted use criteria in all accessible areas of the facility.

Residual radioactive materials remaining in the facility have been isolated or shielded to protect site visitors and workers.

Estimates of the radiological inventory in the entombed reactor monolith are presented in Table 1. Estimates of the radiological inventory in the piping and other systems external to the concrete monolith entombment following decontamination are presented in Table 2. Following completion of decommissioning operations, approximately 0.013 Curies of radioactivity was contained in the form of scale in piping and components external to the entombment system, while approximately 53,000 Curies was contained within the entombment system (PRWRA 1970). Present-day inventories are reduced as a consequence of radioactive decay, to less than 900 Curies within the entombment and less than 900 µCi in the external systems. As shown in Tables 1 and 2, Ni-63 is the predominant radionuclide remaining in the entombed materials and Cs-137 is the predominant radionuclide remaining in the external systems. Since Ni-63 has a radioactive half-life that is much longer (96 years) than other radionuclides of concern, it's relative contribution to the total activity at the site will continue to increase over time.

Radiological materials that were removed during decommissioning were transported to an approved off-site disposal facility on the U.S. mainland (Oak Ridge, Tennessee). Following completion of decommissioning activities, the AEC and PRWRA entered into a contract (AT-(40-1)-4186) in 1971 for the surveillance and maintenance of the reactor containment system and monitoring of radiation at the facility. In accordance with this contract, the components and materials contained within the entombed structure remain the property of DOE. In 1974, the original 1960 contract (AT-(40-1)-2672) between AEC and PRWRA was terminated. During the 1990s, contract AT-(40-1)-4186 ceased to be administered and the work was performed by DOE. Radiological monitoring and surveillance has continued at the facility, as discussed in the following section, to assure the protection of public health and the environment, although the potential for radiological exposure of the public is considered to be low.

Table 1. Estimates of Principal Radionuclides Entombed in the BONUS Reactor

| Radionuclide | Half-Life | Activity (Curies) | |
|---|---|---|---|
| | | August 1968 (PRWRA 1970) | 2001 |
| Cobalt-57 | 271 days | 2,229 | 0 |
| Cobalt-60 | 5.27 years | 15,581 | 203 |
| Nickel-63 | 96 years | 840 | 669 |
| Manganese-54 | 312 days | 1,023 | 0 |
| Iron-55 | 2.7 years | 33,586 | 7 |
| TOTAL | - | 53,259 | 879 |

Table 2. Estimates of Principal Radionuclides in the BONUS Reactor Systems External to the Entombment

| Radionuclide | Half-Life | Activity (Curies) | |
|---|---|---|---|
| | | 1968 (PRWRA 1970) | 2001 |
| Manganese-54 | 312 days | 0.00011 | - |
| Cobalt-60 | 5.27 years | 0.010 | 0.00017 |
| Zinc-65 | 244 days | 0.0016 | - |
| Silver-110m | 250 days | 0.0000084 | - |
| Antimony-125 | 2.77 years | 0.000038 | - |
| Cesium-137 | 30 years | 0.0015 | 0.00071 |
| TOTAL | - | 0.013 | 0.00088 |

DOE and PREPA are developing a memorandum of understanding (MOU) to establish an enforceable contractual mechanism which delineates the responsibilities and authorities of the two parties with respect to residual radioactive material remaining at the BONUS facility (DOE/PREPA 2001). Under the terms of this agreement, DOE has responsibility for providing radiological oversight and for performing maintenance and restoration of the entombment to a safe condition (from a radiological standpoint), or other appropriate action, in the event that the containment is disturbed in the future by natural deterioration or accident, or is otherwise determined by DOE to be inadequate. PREPA has responsibility for: conducting quarterly radiological measurements in accordance with the approved Radiation Protection Program (RPP)(Jacobs 1998b) for the facility, and a comprehensive annual survey and inspection to assess radiological conditions throughout the facility; record keeping and reporting; and facility control and maintenance. The quarterly inspections of the facility must include an evaluation of the structural adequacy of the building, the general condition of the containment features of both the entombment and external systems, and the condition of areas to which the public has access.

## 1.3 SUMMARY OF RADIOLOGICAL CONDITIONS AT THE BONUS FACILITY

Radiological conditions following decommissioning of the facility were documented in the *Boiling Nuclear Superheater Power Station Decommissioning Final Report* (PRWRA 1970). Following decommissioning of the facility, United Nuclear Corporation collected 284 smears from floor and wall surfaces of the containment building. Removable beta-gamma activity[1] levels were measured from nondetect to 418 dpm/100 $cm^2$. An additional 120 smears were collected at various locations on the entombment structure, with results ranging from nondetect to 107 dpm/100 $cm^2$ beta-gamma; exposure rate measurements[2] at these locations ranged from 0.01 to 0.15 mR/hr. Soil samples were collected along the beach in the area of the discharge Post

---

[1] Radioactivity on building/equipment surfaces is measured in terms of disintegrations per minute (dpm) per unit surface area (100 $cm^2$). Removable activity refers to that portion of the total radioactivity which is accumulated by wiping a cloth or paper "smear" across the surface. DOE has specified criteria for acceptable levels of surface radioactivity for several categories of radionuclides. Since the primary radionuclides of concern (see Tables 1 and 2) at the BONUS facility emit only beta particles and/or gamma radiation, the beta-gamma category is the appropriate point of comparison. The guidelines for allowable residual surface contamination for unrestricted release for this category of radionuclides are specified in DOE Order 5400.5 (DOE 1990) as 5000 dpm/100 $cm^2$ for total activity and 1000 dpm/100 $cm^2$ for removable activity.

[2] Exposure rate is a measure of the ionization produced by gamma radiation in air per unit time, with units of micro-roentgen per hour (µR/hr). Since radiation is always present in the natural environment due to cosmic and terrestrial radiation sources, the measured exposure rate should be compared to a site-specific background reading. The natural background exposure rate at the BONUS facility is approximately 5 µR/hr (Jacobs 1998a).

tunnel and in close proximity to the containment building; no radionuclides were found at identifiable quantities in any sample.

Post decommissioning surveys have been conducted on an annual basis and indicate no increases in radiation levels. Some of the observations have noted concerns from weathering on the outside of the structure, extensive overgrowth around the facility, the presence of friable asbestos, and flooding of the basement which prevented sampling during one reporting period.

A radiological survey was conducted in 1996 to evaluate levels of residual radioactivity in the facility (Auxier 1996). Residue samples were collected from the facility to identify radionuclides of concern and their relative abundances. The primary radionuclide was found to be Cesium-137 (72%), with smaller quantities of Nickel-63 (22%), Strontium-90 (3%), and Cobalt-60 (3%). (Note that these results differ somewhat from the radionuclide inventory determined in the facility decommissioning report (PRWRA 1970)(see Tables 1 and 2), which found Ni-63 to be the predominant contributor to the total facility inventory by far, but restricted to the entombment system only, and Cs-137 to be the predominant contributor to the inventory in the external systems. Strontium-90 was not identified at all as a contributor to the radionuclide inventory in the decommissioning report, but was identified as a minor contributor in the Auxier analysis.)

Exposure rate measurements inside the containment building indicated radiation levels ranging from 5 to 9 µR/hr in the entrance building, 5 to 10 µR/hr on the basement floor, 4 to 6 µR/hr on the main operating floor, and 3 to 8 µR/hr on the mezzanines and upper surfaces of the reactor. These results are generally similar to the natural background exposure rate of ~ 5 µR/hr at this site. Elevated radiation levels were found on the basement and main operating floors in isolated locations, with most of these areas associated with liquid handling systems or larger reactor components. The maximum radiation level was measured at 500 µR/hr on the north surface of the main operating floor entombment at a height of about 15 to 30 cm above the floor surface. Other components ranged from 15 to 30 µR/hr on contact. Many of the plugged floor drains on the basement floor had elevated radiation levels on contact but the levels decreased to the general area exposure range at approximately one meter from the source.

The 1996 survey personnel also performed a general clean-up of the building, and disposed of approximately 25 truck-loads of materials from the facility, collected primarily from the former Health Physics Office, the former Chemistry Laboratory, and the former Supervisor's Office. Removal of these materials was necessary to allow access to floor areas for survey. It was estimated that these materials covered approximately 50% of the floor space and restricted access to the floor and lower wall surfaces for radiological characterization. Records related to BONUS operations and items of equipment of potential historical significance were segregated and retained. Visual inspection and radiological survey measurements were used to identify low-activity sources and contaminated materials which were not suitable for unrestricted release. Such items were generally relocated to the former Health Physics Office for further evaluation and disposition by PREPA. Items containing other (non-radioactive) potentially hazardous substances were also identified, and generally relocated to the former Chemistry Laboratory for further evaluation and disposition by PREPA. No detectable contamination was identified on the other materials surveyed. Of these materials, 25 batches of BONUS-related records were retained in the former Supervisor's Office, while the remainder were sent for disposal at an off-site landfill as nonhazardous waste.

In 1997, a detailed characterization survey was performed to assess the levels of radioactivity remaining at the BONUS facility (Shonka 1997, Jacobs 1998a). This survey evaluated 100% of accessible floor surfaces for fixed and removable beta-gamma contamination, as well as walls to a minimum height of 3 feet above the floor surface. A survey of external exposure rates also was performed. Air samples collected within the building found no detectable airborne activity (minimum detectable level = $9.9 \times 10^{-12}$ µCi/ml). Soil samples were collected from areas adjacent to the building, and groundwater monitoring wells were installed to sample shallow groundwater; no radionuclides potentially attributable to BONUS operations were identified in any soil or groundwater samples. The relative abundance of radionuclides in a sample of dust collected from the basement floor was estimated at 88.66% Cs-137, 9.14% Ni-63, 1.36% Co-60, and 0.84% Sr-90. A summary of the surface contamination data is presented in Table 3.

Table 3. BONUS reactor building Radiological Measurements (Jacobs 1998a).

| BONUS reactor building Location | Surface Count Rate (dpm/100 cm$^2$) | Surface Activity Concentration (pCi/m$^2$) | | | |
|---|---|---|---|---|---|
| | | Cs-137 | Ni-63 | Co-60 | Sr-90 |
| Main Reactor Ring | 1.98E+04 | 7.96E+05 | 8.21E+04 | 1.22E+04 | 7.54E+03 |
| Reactor Top & Mezzanine | 1.51E+05 | 6.09E+06 | 6.28E+05 | 9.32E+04 | 5.76E+04 |
| Main Rooms | 9.25E+03 | 3.73E+05 | 3.84E+04 | 5.71E+03 | 3.53E+03 |
| Center | 1.74E+06 | 7.01E+07 | 7.23E+06 | 1.07E+06 | 6.64E+05 |
| Basement | 1.25E+05 | 5.02E+06 | 5.17E+05 | 7.68E+04 | 4.75E+04 |
| Main Floor Visitor Area | 1.32E+04 | 5.31E+05 | 5.48E+04 | 8.13E+03 | 5.03E+03 |
| Reactor Floor | 1.62E+05 | 6.55E+06 | 6.75E+05 | 1.00E+05 | 6.20E+04 |

This surface contamination survey was conducted in a manner to assure a detection limit of 1000 dpm/100 cm$^2$ (dpa) averaged over 1 m$^2$. The survey was designed to identify any localized areas of contamination (hot spots) with more than 3-times the average limit (3000 dpa). The detection of such hot spots was difficult due to elevated and highly variable background radiation fields. Because of background measurement variability and reduced survey areas, some of the localized areas of elevated contamination reported in the survey at levels above 3000 dpa may actually be below the criteria. Where possible, the survey utilized a surface contamination monitor (SCM) device, which uses an array of computerized radiation detectors including a position-sensitive proportional counter, to scan entire surface areas. Areas of elevated contamination exceeding release limits included portions of the basement, particularly the southwest quadrant of the basement, and localized areas of the main floor and mezzanine. Survey results included the following:

**Theater:** The theater was measured in a single survey using the SCM. None of the 1 $m^2$ areas were measured to exceed 1000 dpa and only a single 100-$cm^2$ area exceeded the 3000 dpa criterion. This reading was believed to be a false positive attributed to variability in background.

**Basement:** Most survey areas in the basement were found to have one or more 1 $m^2$ sections exceeding 1000 dpa. The highest levels of contamination were found in the southwest quadrant of the basement around process equipment and appeared to be the result of a liquid spill. Localized contamination (46,000 dpa) was found on a concrete pad behind the 4000-gallon retention tank. The Intake Blower Room also had a large area of contamination. Localized contamination exceeding 250,000 dpa (100,000 dpa averaged over 1 $m^2$) was observed in the Condenser Resin Regeneration Room and appeared to be associated with a historic spill. High readings (16,369 dpa over 1 $m^2$) were also observed in the Reactor Feedwater Room located near the reactor in the northwest quadrant of the basement. The portion of the basement of potentially greatest interest for this EA is the outside region of the northwest quadrant of the basement near the stairway, as this area has been identified by PREPA as potentially suitable for visitor tours; this area was surveyed using both SCM and manual methods, and all areas were found to be below criteria.

**Main Floor:** One area of the main floor immediately east of the reactor had activities greater than 1,500,000 dpa (111,856 dpa averaged over 1 $m^2$). This area also had the highest exposure rate measured in the survey, ranging from more than 150 µR/hr at contact to 50 µR/hr at one meter; this area was covered with lead bricks by the survey team before demobilizing. The 3000 dpa maximum criterion was exceeded in approximately 19% of the floor area that was surveyed. Most of the areas in the outer ring were found to be below the 1000 dpa average criterion.

**Reactor Top and Mezzanine:** Approximately 87% of the areas surveyed were below the 1000 dpa average criterion. A localized area of contamination (150,000 dpa) was found in the Fuel Transfer Assembly Track in the reactor top. Because of the location, the actual level of contamination may be higher than measured.

No removable radioactivity above the minimum detectable activity (MDA) for the instruments was identified on the main operations floor or walls, or the mezzanine floor or walls. Removable activity above MDAs but below criteria for unrestricted release specified in DOE Order 5400.5 (1000 dpa) was identified in some areas of the basement.

Surveys of the upper walls (3 to 10 feet above the floor) found no fixed or removable activity above MDA levels.

The natural background exposure rate was estimated at approximately 5 µR/hr at the site perimeter. All areas of the site were within the range of natural background with the exception of two areas: a location near the emergency air lock which had readings of 10 µR/hr at 1 m, and a location near the reactor air exhaust stack, which readings of 320 µR/hr at contact with the ground surface and 17 µR/hr at 1 m. This second location was determined to be due to 2 contaminated bolts, and readings returned to background levels after these bolts were removed.

Based on the results of this survey, the following recommendations were made to reduce the potential for exposure to radioactive material:

- Cover[3] the higher level of radioactivity found on the floor near the north reactor face under the pipe coupling with a minimum of 25.4 cm (10 inches) of concrete, to reduce the 1-m exposure rate to facility background levels.

- General cleaning (sweeping and mopping) of the basement to collect loose radioactivity.

- Prohibit public access to the basement or assure by some means (e.g., security guard, raise the height of the plexiglass wall) that the public cannot climb over the Plexiglass wall. Public access should also be prohibited from other areas of the reactor, including the 4000-gal Retention Tank Room, Condensate Pump Room, Reactor Purification and Reheat Room, Reactor Feedwater Room, Condensate Regeneration Room, and the Vapor Sphere Room; these rooms should be secured with a locking door or similar barrier to prevent public access.

- Paint or otherwise cover (e.g., tile) floors[3] in all areas that will be accessible to the public, to ensure that any residual radioacitivity will remain fixed and does not become

[3] In cases where residual radioactivity cannot be readily removed to achieve criteria, these areas may be covered to reduce potential radiation exposures. Cover materials may include paint, floor tiles, concrete, etc. The purpose of such materials is both to provide additional shielding which will reduce external exposure rates and also to help to ensure that the residual radioactivity remains fixed to building surfaces and does not become readily removable.

removable in the future.  If paint is used, two coats of different colors should be applied, so it will be evident when the surface coat begins to show through.

All of these recommended actions were completed during 1999.

# 2. DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

## 2.1 PROPOSED ACTION: AUTHORIZING THE PUERTO RICO ELECTRIC POWER AUTHORITY (PREPA) TO ALLOW PUBLIC ACCESS TO THE BONUS REACTOR BUILDING WITH EXISTING CONTROLS

DOE proposes to consent to the proposal made by PREPA to allow public access to a museum to be developed within the BONUS reactor building. Under the proposed action, DOE would continue to provide radiological oversight for the facility, including monitoring and surveillance of the concrete monolith within the BONUS reactor building, to ensure that no unacceptable radiation exposures occur.

Public access would be allowed in the outer portion of the ring on the reactor floor. Public access to the basement and the other portions of the reactor building interior would be prohibited. Metal or plexiglass barricades and other physical barriers have been installed to prevent access to these areas, and these physical and administrative controls would be maintained under the proposed action. Residual radioactive materials exist in portions of the building where public access would be allowed, but are primarily fixed in place, and not removable.

## 2.2 REASONABLE ALTERNATIVES TO THE PROPOSED ACTION

### 2.2.1 No-Action Alternative

The no-action alternative is considered in accordance with the requirements of National Environmental Policy Act (NEPA) regulations (40 CFR 1500-1508), and provides a baseline against which the proposed action and other alternatives can be compared. Under this alternative, public access to the facility would not be allowed and the proposed development of a museum at this location would not proceed. Radiological monitoring and surveillance of the BONUS facility by DOE would be continued.

### 2.2.2 Authorizing PREPA to allow public access to the BONUS reactor building following additional decontamination

Under this alternative, additional decontamination would be performed in those areas where levels of residual radioactive materials remain above guidelines for unrestricted release specified in DOE Order 5400.5 (DOE 1990), in order to further reduce radioactivity levels within the facility. Residual radioactivity above DOE guidelines would be removed using standard decontamination techniques, such as scabbling of concrete surfaces, or additional shielding materials would be installed to reduce potential radiation exposures. Since the concrete monolith entombed within the facility would remain in place, residual radioactivity would remain at the facility above the DOE guidelines for unrestricted release. Therefore, continued radiological monitoring and surveillance of the facility would be required.

Following completion of the additional decontamination efforts, public access to a museum developed at the BONUS facility would be allowed. Public access would be allowed in the outer portion of the ring on the reactor floor and other specified areas of the building where residual radioactivity meets DOE guidelines; public access to the reactor monolith and any portions of the building containing residual radioactivity above DOE guidelines would be prohibited. Metal or plexiglass barricades and other physical barriers and administrative controls would be maintained to prevent access to these areas under this alternative.

## 2.3 ADDITIONAL ALTERNATIVES CONSIDERED BUT NOT EVALUATED IN DETAIL

**Complete Decontamination, Including Removal and Off-Site Disposal of the Monolith:** The demolition and removal of the concrete monolith entombed within the BONUS reactor building for disposal at an approved off-site disposal facility was also considered. Under this alternative, all residual radioactive materials above guidelines for unrestricted release in DOE Order 5400.5 (DOE 1990) would be decontaminated and removed from the facility, including the entombed monolith structure. Following completion of all demolition and decontamination activities, continued radiological monitoring and surveillance of the facility would not be required. While this alternative is considered to be technically implementable, it would be extremely expensive without commensurate benefits in risk reduction. Moreover, this alternative would be likely to result in physical and structural damage to the facility that would diminish its potential value for use as a museum or other productive reuse. Therefore, this alternative was eliminated from detailed consideration as a reasonable alternative.

**Structural Enhancement of the Building and Monolith Structure:** Under this alternative, structural enhancements to the BONUS reactor building and/or monolith structure would be implemented to provide improved stability during seismic events and hurricanes. The BONUS facility has weathered multiple earthquakes and hurricanes, without evidence of major damage. Moreover, the physical characteristics of residual radioactive materials at the facility, particularly the concrete monolith that contains the primary radiological inventory, would preclude releases to the environment even in the event of structural damage to the facility - i.e., the inventory of residual radioactivity at the facility is primarily contained within the concrete monolith (i.e., the reactor vessel and associated piping and systems were filled with grout or concrete and encased in a reinforced concrete shell) and is not readily dispersible, even under the most extreme scenarios, and no gaseous or liquid materials are present that might be susceptible to release. Structural modifications of the containment building and monolith would be extremely expensive, but would not provide commensurate benefits in risk reduction. Therefore, this alternative was eliminated from detailed consideration as a reasonable alternative.

# 3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

## 3.1 BONUS FACILITY

The BONUS facility is located on the westernmost part of Puerto Rico near the city of Rincón. The facility is located on a point (Punta Higuera) near the El Faro lighthouse. The facility consists of approximately 2 hectares (5 acres) of land and is completely surrounded by a fence. The BONUS facility is currently owned and controlled by PREPA.

The BONUS facility includes the domed reactor building containing the entombed reactor systems, and outside support structures. The reactor building has three general levels: the basement, reactor floor (main level), and the mezzanine. The dome of the reactor building is constructed of steel plates mounted on a reinforced concrete circular foundation. The reactor assembly and surrounding frames are constructed of steel, while the floor slabs are constructed of reinforced concrete. As discussed in Section 1.2, the reactor assembly in the central portion of the building was filled with concrete and grout in 1970 to form a concrete entombment structure. The exterior accessory building also is made of reinforced concrete. The site currently has parking areas with a capacity of approximately 100 vehicles.

The reactor building, including the main level, which has been proposed for public access, has areas with elevated levels of residual radioactive material. These areas have been isolated or shielded to protect the museum visitors and workers.

## 3.2 LAND USE

The BONUS facility is owned by PREPA. The facility has been inactive since termination of operations in 1968. Prior to that time, the facility was an operating nuclear reactor from 1962 to 1968. The BONUS facility is located adjacent to a beach, which is actively used for surfing and other recreational activities. The fenced area at the BONUS facility is approximately five acres. An additional 137 acres outside the fenced area are also owned by PREPA. A paved road inside the site gives access to El Faro lighthouse and to the BONUS facility. A portion of the BONUS site is zoned for residential use, while the remainder of the site is not zoned.

The nearest community is Barrio Puntas, approximately one mile to the northwest. The town of Rincón is located approximately 2 miles to the southeast. Land use in Rincón includes mixed residential and light commercial activities typical of a tropical beach community. Approximately 388 businesses pay municipal taxes in Rincón; these include restaurants, bars, supermarkets, gasoline stations, and hotels/guesthouses. The two major factories in Rincón are Medical Sterile Products, which manufactures surgical equipment, and Flexible Packing Company, which manufactures cardboard products.

## 3.3 CLIMATE AND TOPOGRAPHY

The regional climate is classified as tropical marine, with warm temperatures and high humidity throughout most of the year. The average daily temperature in the coastal region near the BONUS site is approximately 80 °F. The maximum and minimum temperatures ever measured by the U.S. Weather Bureau in San Juan are 97°F and 70°F, respectively. The average annual precipitation in the coastal regions is approximately 40-150 inches (101-381 cm), with the northern coast receiving twice as much rain as the southern coast. Precipitation is greatest during April through November, with the dry season occurring from December through March. Most of Puerto Rico's rainfall is orographic in nature - i.e., moisture-laden air is cooled while ascending over the mountains, causing condensation in the form of rain. The prevailing wind direction in the area is from the East over most of the island, although wind directions in some coastal areas reflect diurnal variations.

Hurricanes frequently occur between August and October. The most destructive hurricanes in the island's recorded history included San Ciriaco in August 1899, Hurricane San Ciprian in September 1932, and Hurricane Georges in September 1998. In each case, the storms crossed Puerto Rico in a generally East-to-West direction, exacting severe damage to the island. The BONUS reactor building was designed to withstand wind velocities of 150 miles per hour; no structural damage has been observed from storms to date.

The climate within different portions of the island is highly variable, ranging from humid in the northeast corner, where the El Yunque Rain Forest is located, to dry in the southwest, where the Guanica Dry Forest is located. This situation results from the interaction of the Cordillera Central mountain range and the trade winds coming from the Atlantic Ocean.

Puerto Rico is located approximately 1000 miles (1600 km) to the southeast of Miami, Florida, and approximately 500 miles (800 km) to the north of Venezuela. The topography of Puerto Rico is generally mountainous, except for the coastal areas. A coastal plain belt is present in the north, while the mountains descend more precipitously to the sea along the western coast.

The BONUS site is located in the coastal lowlands near Rincón, Puerto Rico, on the western coast. The average elevation of the BONUS reactor building is approximately 25 feet above sea-level. Because of the earthen embankment around the containment building, the modified ground level is approximately 40 feet above sea level. The natural grade slopes down to the sea west of the facility, and upward to the mountains to the east of the facility. The basement of the BONUS reactor building has experienced flooding during hurricane events in recent years.

## 3.4 EARTH RESOURCES

### 3.4.1 Geology

The island of Puerto Rico is roughly rectangular in shape, approximately 100 miles (160 km) by 35 miles (60 km), and is the smallest and most eastern island of the Greater Antilles. In addition to the principal island, the Commonwealth includes Vieques, Culebra, Culebrita, Palomino, Mona, Monito, and various other isolated islands. The islands of Vieques and Culebra are located a short distance from the east coast of Puerto Rico, and are municipalities of Puerto Rico. These three islands are the only ones with permanent inhabitants. Other important islands include Mona, 40 miles (72 km) to the west, an important natural reserve, and the nearby island of Monito, and Desecheo which is visible from the west coast of Puerto Rico.

The Mona Passage, which separates the island from Hispaniola to the west, is about 75 miles (120 km) wide and more than 3300 feet (1000 m) deep, and is a key shipping lane. Off the northern coast is the 28,000 ft (8500 m) deep Puerto Rico Trench, and to the south the sea bottom descends to the 16,400 ft (5000 m) deep Venezuelan Basin of the Caribbean.

The island of Puerto Rico has three main physiographic regions. The mountainous interior is formed by a central mountain chain commonly known as the “Cordillera Central” which transects the island from east to west, and several smaller ranges. The coastal lowlands extend approximately 8 to 12 miles (13-19 km) inland in the north and 2 to 8 miles (3 to 13 km) in the south; a series of smaller valleys lie perpendicular near the western and eastern coasts, formed by erosion of the interior mountains. The third major physiographic feature is the karst region in the north, which extends from Aguadilla in the west to Loiza, just east of San Juan. This area consists of formations of limestone rock dissolved by water to form haystack hills, sinkholes, caves, limestone cliffs, and other karst features.

The geology in the central portion of the island consists mostly of tuffaceous sandstones, siltstones, conglomerates, tuffs, volcanic breccias, and flows of Cretaceous to early Tertiary age. Along the margins of the island, Tertiary formations, mostly limestone with a minor amount of sand and clay, trend east-west. The BONUS site is located in the coastal lowland area on the western coast, near Rincón.

Thirty-one (31) core-holes were drilled to determine subsoil conditions during the design and construction of the containment building foundation slab. These cores typically showed the top stratum consisting of silty sand and cemented sand as sandstone in different degrees of strength and varying in thickness from 7 to 17 feet. Some sandstone required boring with a diamond drill. Underlying this upper stratum was a heterogeneous mass of sandy clay and silt with pieces of limestone rock and silt clay or sand. Most of the borings were bottomed in a gray and brown silty clay stratum about 100 feet deep. Three holes were drilled to greater depths in an effort to reach bedrock, but none was found.

### 3.4.2 Soils

Soils on the island of Puerto Rico may be classified according to the U.S. Soil Conservation Service classification system as humid coastal plains, semiarid coastal plains, humid uplands, semiarid uplands, and humid upland valleys. Another classification system by the University of Puerto Rico groups the island's soils as coastal lowlands, alluvium, coastal plains, alluvium in terraces, upland dark, and upland reddish-purple. Soil types are primarily sandy textured in the coastal areas, with a mixture of sandy diorite-derived and clay in the forest areas.

Soil maps for Puerto Rico indicate the presence of the soil order Oxisols in the vicinity of the BONUS facility. These soils are highly weathered and characterized by the presence of oxidized iron. They have a reddish color, and are dominated by hydrous oxides of iron and aluminum, making them relatively infertile.

In the immediate vicinity of the BONUS site, soils have been observed to consist primarily of yellowish-brown clays of medium plasticity with several thin lenses of highly cemented sands and calcareous sandstone nodules. A highly weathered limestone unit begins approximately 7 to 8 m (23 to 28 ft) below ground surface, and contains shallow groundwater. (Jacobs 1998a) As noted in the previous section, borings made prior to construction of the BONUS facility found soils to consist of silty sand, dark sandy clay, and sandstone.

Colinas clay loam occurs on side slopes and ridge tops of limestone hills at the site, on 20 to 60 percent slopes. The soil has a surface layer of dark-brown clay loam, a thin light-colored subsoil, and a very thick substratum of soft limestone. In some areas, soft limestone is exposed on the surface in small outcroppings, particularly on hilltops. Soils at the BONUS site are not considered suitable for cultivation, due to shallow depth, past erosion, slope and rapid runoff.

### 3.4.3 Seismicity

Puerto Rico is located in an active seismic region (Zone 2 category). Numerous earthquakes have been recorded in this area, dating from 1615 to the present. The strongest earthquakes impacting Puerto Rico occurred in 1670, 1787, 1867, and 1918, resulting in numerous fatalities and severe economic damage. During 2000, 735 seismic events were detected in this region by the Puerto Rico Seismic Network, representing an increase of 20% from the previous year (586 events in 1999)(PRSN 2001). The month of greatest seismic activity was May, with 51 events. Of these, only 2.3% were reported as felt. The largest earthquake during 2000 occurred on December 11, with a magnitude of 4.9 (Richter Scale) and intensity of IV (Modified Mercalli Scale). Within the island of Puerto Rico, the most active region is to the south of an imaginary line that extends from Rincón to Guayama.

No evidence of damage (e.g., cracks, corrosion, wear or deflections of concrete or metal components) to the BONUS facility as a result of seismic events has been identified to date. The physical characteristics of the entombed reactor system would not be susceptible to release of hazardous materials even in the event of structural damage due to a severe seismic event or hurricane - i.e., the reactor vessel and all associated piping and facilities have been filled with grout or concrete, and encased in a reinforced concrete shell; and no liquid or gaseous materials are present that might be susceptible to release.

## 3.5 WATER RESOURCES

### 3.5.1 Surface Water

Puerto Rico has numerous streams and rivers, generally running from the mountainous interior to the coastal areas, primarily to the north and west. The largest rivers are La Plata, Loiza, and Arecibo, all draining to the north, and the Añasco, draining to the west. Many of the rivers draining to the south run dry most of the year, but can cause flooding under conditions of heavy rainfall. The Central Range divides the north (Atlantic) and south (Caribbean) watersheds. Puerto Rican rivers are not navigable except near the coasts. Puerto Rico has no natural lakes, but numerous reservoirs formed by damming rivers to produce hydroelectric power and water for irrigation. Other than the ocean, no major surface water features are present at the BONUS site.

### 3.5.2 Groundwater

Puerto Rico has abundant subterranean streams, particularly in the karst region in the north. The karst region is characterized by haystack-shaped hills surrounded by deep circular depressions. An underground river system has developed over millions of years within the limestone rich terrain, including the third largest subterranean river in the world, Rio Camuy. An important thermal fountain is "Los Baños de Coamo" at Coamo. Saline-water intrusion is a common problem in some coastal areas, where the withdrawal of fresh groundwater for water supply and other uses can cause the saline water that underlies coastal aquifers to intrude into the fresher parts of the aquifers. The U.S. Geological Survey and the Puerto Rico Aqueduct and Sewer Authority are monitoring saline water intrusion conditions in the northern coastal region west of San Juan and the Yabucoa Valley in the southeast.

In the immediate area of the BONUS site, shallow groundwater occurs in a weathered limestone unit. Three monitoring wells installed at the site in 1997 encountered groundwater (static water level) at depths of approximately 7 to 12 m (23 to 40 ft) below ground surface (Jacobs 1998a).

### 3.5.3 Floodplains

The BONUS site does not lie within the 100-year floodplain of any surface water body. The site is located approximately 100 m (300 ft) inland from the ocean at an elevation of approximately 8 m (25 ft) above sea level.

### 3.5.4 Wetlands

No wetlands have been identified at the BONUS site.

## 3.6 AIR QUALITY AND NOISE

### 3.6.1 Air Quality

Air quality in the vicinity of the BONUS site is considered good. Offshore winds from the west help to prevent stagnation or inversion conditions at the site. There is no air monitoring station in the vicinity of Rincón. However, air quality data for other locations throughout Puerto Rico indicates that the commonwealth meets standards for all priority air pollutants, with the exception of particulate matter (PM10) in a portion of Guaynabo County in north-central Puerto Rico (EPA 2001).

### 3.6.2 Noise

The BONUS site is located in a non-industrialized area adjacent to the ocean shoreline near Rincón, Puerto Rico. Noise levels may be categorized as low to moderate.

## 3.7 BIOLOGICAL RESOURCES

### 3.7.1 Vegetation

Several thousand varieties of tropical plants grow in Puerto Rico, including the kapok tree, poinciana, breadfruit, and coconut palm. Common plants of the coastal lowlands in the area of the BONUS site in the western portion of the island also include cactus and bunch grass. A topical rainforest located in the northeastern portion of the island is vegetated with an estimated 240 types of trees, 50 species of ferns, 20 varieties of wild orchids, and many other species. A portion of this rain forest is within the Caribbean National Forest (also known as El Yunque).

Dwarf cloud forests are located at the highest altitudes, with palms, ferns, and epiphytes. On exposed ridges, these forests may have a windswept appearance. Below the dwarf forest is the rain forest, and below that is the subtropical wet forest, with open-crowned trees and canopy trees such as *Cyrilla racemilflora*. Classifications below this include the lower wet forest (Tabanuco) and the subtropical moist forest zone, which covers most of Puerto Rico, including the area to the east of the BONUS site. Dry forest is found along the south coast and the eastern tip of the island.

The immediate vicinity of the BONUS site is primarily vegetated in brush, native pasture and woodland.

### 3.7.2 Wildlife

Wildlife in Puerto Rico includes no large mammals. The mongoose was brought to the island to control rats on sugar cane plantations. Iguanas and many smaller lizards are common. Bats are the only indigenous mammal remaining in Puerto Rico, with 11 of the 13 species of bats residing in the tropical rain forest. More than 2000 caves discovered to date in Puerto Rico provide abundant habitat for these bats; however, none have been observed at the BONUS site. The tiny coqui tree frog is unique to Puerto Rico. Sixteen species of coqui tree frogs have been identified, with most residing in the tropical rain forest and central mountain range.

Bird species occurring in the vicinity of the BONUS facility include the cattle egret (*Bubulcus ibis*), american kestrel (*Falco sparverius*), Puerto Rican woodpecker *(Melanerpes portoricensis*), purple martin (*Progne subis*), gray kingbird (*Tyrannus dominicensis*), black-whiskered vireo (*Vireo altiloquus*), northern mockingbird (*Mimus polyglottos*), bananaquit (*Coereba flaveola*), yellow warbler (*Dendroica petechia*), black-faced grassquit (*Tiaris bicolor*), black-cowled priole (*Icterus dominicensis*), and Greater Antillian grackle (*Quiscalus niger*). The Puerto Rican woodpecker is endemic to the island of Puerto Rico and is known to nest on the BONUS property.

### 3.7.3 Threatened and Endangered Species

Presently there are 49 plant species and 29 animal species in Puerto Rico and the U.S. Virgin Islands protected as either threatened or endangered under the Endangered Species Act of 1973 (FWS 2001b). The Commonwealth of Puerto Rico provides protection to these and additional animal species.

The BONUS reactor facility falls within the range of the endangered hawksbill sea turtle (*Eretmochelys imbricata*), the leatherback sea turtle (*Dermochelys coriacea*), and the endangered plant *Buxus vahlii*. The beaches adjacent to the facility provide potential nesting habitat for the two species of sea turtle. A population of *Buxus vahlii* is present on property owned by PREPA adjacent to the BONUS facility. This plant species is known to exist only on Puerto Rico and St. Croix, and this is one of five known locations on the island of Puerto Rico, and one of the largest populations.

## 3.8 CULTURAL RESOURCES

Puerto Rico was discovered by Christopher Columbus in 1493, and ceded by Spain to the United States in 1898 following the Spanish-American War. In elections held in 1967 and 1993, voters have chosen to retain Commonwealth status.

The most important archeological site in the Caribbean area is the Tibes Indigenous Ceremonial Center near Ponce, Puerto Rico. This site is a ceremonial ballpark of the Taino Indians, who dominated Puerto Rico until the arrival of the Conquistadores in 1500. It represents the continuous habitation of indigenous people more than 1000 years before the arrival of Columbus. This site, discovered as a result of Hurricane Eloisa in 1975, receives more than 80,000 visitors per year, ranging from professional archeologists and anthropologists to numerous Puerto Rican schoolchildren learning of their indigenous heritage. However, this site is located on the south-central coast of Puerto Rico, distant from the BONUS facility.

## 3.9 SOCIAL AND ECONOMIC CONDITIONS

### 3.9.1 Demography

Rincón, Puerto Rico has an estimated population of 14,767 persons as of 2000 (USCB 2000), an increase of 17% from the 1990 population of 12,213 persons. This rate of growth is slightly higher than that for the Commonwealth of Puerto Rico as a whole, which increased from 3,522,037 persons in 1990 to an estimated 3,808,610 persons in 2000, or 10%.

### 3.9.2 Economic Activities

Puerto Rico has one of the most active economies in the Caribbean region. A diverse industrial sector has surpassed agriculture as the dominant economic activity. Major industries include pharmaceuticals, electronics, and apparel manufacturing. Primary agricultural products include sugar, dairy production and other livestock products. Tourism is also an important source of income for Puerto Rico, with an estimated 5 million tourists visiting the island in 1999. Estimated employment is approximately 3% agriculture, 20% industry, and 77% services, and the unemployment rate is estimated at approximately 13%.

The BONUS site is located near Rincón on the western coast. Businesses in Rincón include restaurants, bars, bakeries, supermarkets, gasoline stations, hotels/guesthouses, and two major factories (Medical Sterile Products, Flexible Packing Company). Tourism is a major industry, with activities including surfing, whale-watching, fishing, snorkeling/scuba diving, boating, and sightseeing. Tourism is most active during December through March (local and foreign tourists) and May through August (primarily local tourists). Sites commonly visited by tourists include the Santana-Caro Home (site of the Tourist Information Office), the Centro Cultural Rincoeño, and the Parque Pasivo El Faro lighthouse.

### 3.9.3 Environmental Justice

U.S. Census data estimate that approximately 97.6% of the population of Rincón and 98.8% of the population of Puerto Rico are Hispanic or Latino (USCB 2000). Accordingly the majority of the residents and workers in the vicinity of the BONUS site are Hispanic or Latino. There are no identified areas of low-income populations in the immediate vicinity of the BONUS site.

### 3.9.4 Transportation

The BONUS site is located near Rincón, approximately 100 miles west from San Juan. Highways serving the area include State Road 2 and State Road 115. Rincón also can be accessed by sea, and has a boat basin (shallow draft channel) located just south of the lighthouse.

Private automobiles are the primary mode of transportation in the local area, with most local residents owning at least one car. There is also a small fleet of cars called "públicos" that are available to transport people from the town to any of the nine counties and nearby towns, such as Mayagüez and Aguadilla; however, the públicos appear to be little used. The municipal government also runs a trolley from the town center to the post office, located approximately one-half mile from town.

## 3.10 EXISTING RADIOLOGICAL AND CHEMICAL EXPOSURES

Results of comprehensive radiological surveys of the BONUS facility are summarized in Section 1.3. Radiation exposure rates outside the BONUS reactor building are at the natural background level of approximately 5 µR/hr. Residual radioactive materials above guidelines for unrestricted release under DOE Order 5400.5 remain within the BONUS building, but physical and administrative controls prevent public access to these areas. The ongoing radiological surveillance and monitoring program includes annual and quaterly surveys.

## 3.11 ACCIDENTS

The BONUS reactor experienced numerous operational problems during its brief operating history. Approximately 106 unintentional reactor scrams[4] occurred during the startup period from April 1965 to December 1965 (West and Fragoso 1966). Another scram occurred in November 1966 after several days of full-power operation; elevated concentrations of airborne radioactivity were detected during this period but did not exceed maximum permissible concentrations (MPC) and the total radioactivity release through the stack was estimated at 15,721 µCi (Fragoso 1966). In May 1966, a high radiation field was detected during the transfer of boiler fuel rods from the reactor core to the fuel storage pool, resulting in doses of approximately 180 mrem and 110 mrem, respectively, to 2 workers during this brief incident (Rivera and Bonnet, 1966).

Since the completion of decommissioning activities in 1970, no accidents have been reported.

[4] A scram is defined as a sudden shutdown of reactor operations, usually by insertion of control rods, either automatically or manually by the reactor operator.

# 4. EVALUATION OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

## 4.1 PROPOSED ACTION: AUTHORIZING PREPA TO ALLOW PUBLIC ACCESS TO THE BONUS REACTOR BUILDING WITH EXISTING CONTROLS

Under the proposed action, PREPA would be allowed to grant public access to a museum to be developed at the BONUS facility. The proposed museum would be located within the existing reactor building. Administrative and engineering controls would be implemented and maintained to reduce the potential for radiation exposure of museum visitors to acceptable levels. Access controls would be implemented to restrict museum visitors to specified areas within the building. Tiles would be laid along the designated pathways and plexiglass barriers erected to prevent access to restricted areas. Workers entering controlled areas would be subject to the regulatory requirements of 10 CFR 835, and appropriate measures would be taken to control the spread of contamination and limit worker doses to acceptable levels. PREPA would conduct periodic radiological monitoring and surveillance of the facility to ensure that existing engineering and administrative controls continue to provide adequate protection of the public.

### 4.1.1 Demography & Socioeconomics

The proposed action would be expected to have positive socioeconomic impacts both in the short-term and long-term. Short-term impacts would include increased employment during the renovation of the BONUS facility and development of the proposed museum. Longer-term impacts would include employment of approximately 9 museum staff (assumed to include 4 tour guides, 1 maintenance worker, 1 secretary, 1 museum curator, 1 administrator, and 1 accountant) and 3 shift guards, and also increased tourism revenues from museum visitors.

#### 4.1.1.1 Environmental Justice

Executive Order 12898 requires federal agencies to achieve environmental justice to the greatest extent practicable by identifying and addressing "disproportionately high and adverse human health or environmental effects of its ... activities on minority populations and low-income populations." For the proposed action, no high and adverse impacts have been identified which would disproportionately affect any minority group or low-income population.

### 4.1.2 Land Use

Implementation of the proposed action would create no negative impacts on land use at the BONUS reactor site. The currently inactive BONUS facility would be operated as a museum for the public benefit. Surrounding land use would be unimpacted, except for the potential development of additional service businesses that might be developed in the vicinity to serve the increased tourist traffic.

### 4.1.3 Geology and Soils

No impacts to geology and soils have been identified. The proposed action would take place within the existing reactor building and would result in renovation of the existing reactor building as a public museum.

### 4.1.4 Air Quality

Negligible impacts to air quality have been identified. There may be some increase in automotive traffic, both by construction workers during development of the museum facility and by visitors to the museum after its opening. However, any increase in traffic congestion and vehicle exhaust emissions would be expected to have negligible impact on local air quality.

### 4.1.5 Hydrology and Water Quality

No impacts to hydrology and water quality have been identified. Under the proposed action, there would be no planned releases to surface water or groundwater.

### 4.1.6 Floodplain/Wetlands

No impacts to floodplains or wetlands have been identified under the proposed action. The BONUS reactor building does not lie within the 100-year floodplain of any surface water body, and no wetlands have been identified at the site. All operations would be conducted within the existing BONUS reactor building. No construction or demolition of structures or alteration of terrain would be required in implementing the proposed action.

### 4.1.7 Ecological Resources

No impacts to ecological resources have been identified for the proposed action. All operations would be conducted within the existing BONUS facility.

#### 4.1.7.1 Threatened or Endangered Species

As noted in Section 3.7.3, the beaches adjacent to the BONUS facility provide potential nesting habitat for the endangered hawksbill sea turtle (*Eretmochelys imbricata*) and leatherback sea turtle (*Dermochelys coriacea*). In addition, the endangered plant *Buxus vahlii* is known to grow on the BONUS property. This site is one of only five known locations on the island of Puerto Rico, and one of the largest populations. These potential concerns were identified through DOE consultation with the U.S. Department of Interior, Fish and Wildlife Service (FWS 2001a, 2001b).

The proposed action would take place entirely within the existing BONUS reactor building. Since the scope of this DOE proposed action is limited to authorizing PREPA to allow public access to the proposed museum, FWS concurred with the DOE determination that no adverse impacts to any threatened or endangered species would be expected under the proposed action (FWS 2002). DOE discussions with PREPA indicate that no new exterior construction is planned for the development of the proposed museum at the BONUS facility, and that no changes in exterior lighting or parking are planned. DOE also has recommended that PREPA should meet with the FWS to discuss measures that could be implemented to minimize any potential impacts of artificial lighting at the proposed museum on possible sea turtle nesting sites and to protect populations of *Buxus vahlii* occurring on the BONUS property (DOE 2002).

### 4.1.8 Historical, Cultural and Archaeological Resources

No adverse impacts to historical, cultural or archeological resources would occur under the proposed action. All activities would be conducted within the existing BONUS reactor building. DOE discussions with the Advisory Council determined that no formal consultation with the State Historic Preservation Office would be required for the proposed action (DOE 2001), and that the proposed action would be considered beneficial to the preservation of historical and cultural resources.

### 4.1.9 Noise

Negligible noise impacts have been identified for the proposed action. A minor, short-term increase in noise may be associated with renovation of the BONUS facility and construction of the proposed museum. Increases in vehicular traffic associated with the new museum would be expected to have a negligible impact on noise over the longer term. Transportation vehicles would meet legal requirements for exhaust noise suppression.

### 4.1.10 Transportation

Negligible transportation impacts have been identified. There may be a minor increase in automotive traffic, both by construction workers during development of the museum facility and by visitors to the museum after its opening. However, any increase in traffic would be expected to have negligible impacts.

### 4.1.11 Human Health and Safety

No detrimental impacts to human health and safety have been identified under the proposed action. Monitoring and surveillance of the renovated BONUS facility would continue to ensure that no radiation exposures in excess of applicable radiological protection standards would occur and that any physical or chemical hazards comply with industrial standards.

#### 4.1.11.1 Radiological Exposure

DOE Order 5400.5 (DOE 1990) establishes the primary dose limit of 100 mrem/year to any member of the public. In addition, all radiation exposure must be reduced below this limit as low as reasonably achievable (ALARA). DOE conducted an ALARA analysis of the BONUS reactor to assess current radiation exposure conditions relative to potential future uses of the facility. The proposed action and the alternatives were assessed and reported (Jacobs 1998c).

PREPA has implemented a Radiation Protection Program (RPP) for the BONUS facility which specifies physical and administrative controls designed to ensure that radiation exposures to facility workers and the public are limited to acceptable levels (Jacobs 1998b). While residual radioactive materials would remain at the facility above the criteria specified in DOE Order 5400.5 for unrestricted release, the potential for exposure of museum visitors and workers would be limited through use of access controls and shielding - i.e., members of the public would not be allowed access to areas containing unacceptable levels of radioactive materials or shielding materials (e.g., concrete, floor tiles, paint) would be installed to cover areas of elevated activity to prevent unacceptable exposures.

Potential radiation exposure hazards at the BONUS facility include internal and external exposure from residual radioactive materials remaining on the floors, walls, reactor systems, and equipment. Potential exposure pathways of concern include direct external exposure, inhalation of suspended particulates, and ingestion of residual radioactive materials. The primary radionuclide of concern is Cesium-137 (Cs-137), followed by lower levels of Nickel-63 (Ni-63), and trace quantities of Cobalt-60 (Co-60) and Strontium-90 (Sr-90).

The ALARA analysis conducted for the BONUS facility (Jacobs 1998c) evaluated opening the facility as a museum. This analysis applied a system of dose limitations comprising three parts:

- Justification - No practice causing exposure of persons to radiation shall be adopted unless its introduction produces a positive net benefit. The justification requirement was fulfilled by the approved documentation, construction, operation, decommissioning and decontamination of the facility.

- Dose limitation - The dose equivalent to individuals shall not exceed the limits recommended for the appropriate circumstance. The projected exposures to individuals visiting and working at the museum are below regulatory exposure limits and are managed through existing physical and administrative controls (RPP) to ensure compliance with the applicable dose limits. This means that the risk of radiation-induced health effects is acceptably below the level of regulatory concern. The low projected exposures to individuals and the implementation of the RPP addressed the issue of dose limitation for the ALARA analysis.

- Optimization - All exposures shall be maintained ALARA, accounting for economic and health effects. The BONUS exposure radiation levels required ALARA optimization to weigh the health effects versus the economic factors. Optimization considers the collective dose to the entire exposed population from radiation sources (measured in person-rem) to be proportional to the number of radiation-induced health effects. These health effects are balanced against the cost of measures that would reduce these doses.

For the proposed action, the ALARA analysis estimated the potential radiation doses for a hypothetical visitor to the museum, a tour guide and worker. The potential dose to hypothetical visitor was estimated at 0.02 mrem/year. The visitor was assumed to be on site 1 day per year for 8 hours. The visitor was assumed to limit his activity to the areas proposed for public access. The visitor was assumed to be exposed to contamination through direct gamma radiation, and ingestion and inhalation of airborne particulate contamination. The potential dose to a hypothetical tour guide was estimated at approximately 6 mrem/year. The tour guide was assumed to be on site 250 days per year for 8 hours per day. The tour guide was assumed to be exposed to contamination through direct gamma radiation, and ingestion and inhalation of airborne particulate contamination. The dose to a worker assumed to spend 8 hours per day for 250 days per year in the area of maximum contamination was estimated at approximately 54 mrem/year. In each case, dose estimates were computed using the RESRAD-BUILD computer code (Yu et al 1994), and the predominant exposure pathway was estimated to be external exposure, with negligible contributions from all other pathways. Estimates for all receptors are below the 100 mrem/year dose limit for members of the public specified in DOE Order 5400.5.

These dose estimates are considered to be conservative - i.e., likely to overestimate any actual doses that may be received by occupants of the BONUS facility. The conservatism of this analysis is supported by consideration of the gamma exposure rates measured at the facility. The exposure rate measured within the BONUS reactor building averaged 10 μR/hour, with a maximum value of 20 μR/hour (Jacobs 1998a). The background exposure rate measured outside the BONUS facility is approximately 5 μR/hour. These values would yield an estimate of approximately 20 mrem/year (including background) for a hypothetical full-time worker who spends 2000 hours per year at the facility. Because the contamination is fixed, any decontamination efforts are expected to be aggressive (i.e. scabbing, painting, tile removal) and costly to yield appreciable dose reductions. Based on the DOE ALARA cost guidance (DOE 1997) for optimization analyses, the justifiable expenditure to reduce this dose background levels is insufficient to accomplish any meaningful dose reductions. On this basis, the estimated doses under the current conditions were determined to be ALARA (Jacobs 1998c).

#### 4.1.11.2 Occupational Safety and Health

No adverse impacts to occupational safety and health have been identified under the proposed action. Workers engaged in surveillance and maintenance activities at the facility would be required to follow requirements of 10 CFR 835 for radiation protection, and all workers at the facility would be subject to applicable requirements of OSHA regulations. With the exception of the residual radioactive materials in the entombed monolith, most hazards associated with the BONUS facility are similar to routine industrial hazards at any industrial complex and can be readily mitigated.

#### 4.1.11.3 Accidents

No accident impacts have been identified under the proposed action. No radioactive or hazardous materials at the facility would be available for release under plausible accident scenarios. Accident impacts associated with the proposed action would be minor. No radioactive or hazardous materials at the facility would be available for release under plausible accident scenarios. Accidents could occur during construction activities or operation of the new museum due to operator error, equipment malfunction, or from natural phenomena, but would be comparable to those at other industrial facilities and would be mitigated through appropriate safety procedures. Transportation accidents also could occur but would be expected to be similar to those that could occur under existing conditions at the BONUS site.

In the event that a person such as an errant visitor gains access to the basement, the exposure rate assuming an eight hour stay will be much less than atypical worker exposure of 54 mrem/year in a year period. In addition this dose is far greater less than the primary dose limit of 100 mrem/year stated by DOE Order 5400.5 (DOE 1990) to any member of the public.

A flood incident involving the basement area is an event that would likely occur when a major hurricane occurs. Historical evidence indicates that the basement experienced flooding during Hurricane Georges in 1998 due to plugged storm drains, defective door seals and runoff. This water was allowed to evaporate from this event and repairs were made to prevent reoccurrence.

In 1969, a Design Based Accident (DBA) analysis was generated by the PRWA and validated by the former AEC Division of Reactor Licensing assuming a severe earthquake and tidal wave scenario. The earthquake was assumed to crack the containment building, the steel entombment liner, the concrete wall around the pressure vessel, the shield tank, the grout between the shield tank and the pressure vessel and finally the bottom of the pressure vessel. The containment building foundation was assumed to remain watertight and to be flooded to the level of the highest adjacent ground which is about 2 feet above of the pressure vessel. It was also assumed that the pressure vessel internals had been corroding at a conservatively high rate and the corrosion products would be released instantaneously into the flood water when the building is flooded. Ingestion and contact dose calculations indicated that the concentrations for Ni-63 did not exceed the maximum permissible body burden (MPBB) of 200 µC for ingestion (Docket No. 115-4). Based on this information, the specifications for construction of the entombment system (PRWRA 1970), and the most recent DOE inspection, the existing entombment is capable of withstanding anticipated accidents.

## 4.2 NO-ACTION ALTERNATIVE (NO AUTHORIZATION FOR PUBLIC ACCESS)

Under the no-action alternative, the current radiation monitoring and surveillance program would continue at the BONUS facility and public access to the facility would not be permitted. Radiological contamination above DOE guidelines for unrestricted release would remain in the facility, primarily in the entombed monolith and the basement.

### 4.2.1 Demography & Socioeconomics

The no-action alternative would have no impact on regional demographic and socioeconomic conditions. No additional jobs would be created in the local economy, and the surveillance and maintenance personnel would visit the site too infrequently to impact the local economy.

#### 4.2.1.1 Environmental Justice

The no-action alternative would have no impacts, which would disproportionately affect any minority group or low-income population.

### 4.2.2 Land Use

Implementation of the no-action alternative would create no impacts on land use at the BONUS reactor site.

### 4.2.3 Geology and Soils

No impacts to geology and soils have been identified under the no-action alternative.

### 4.2.4 Air Quality

No impacts to air quality have been identified under the no-action alternative.

### 4.2.5 Hydrology and Water Quality

No impacts to hydrology and water quality have been identified under the no-action alternative. There would be no planned releases to surface water or groundwater.

### 4.2.6 Floodplain/Wetlands

No impacts to floodplains or wetlands have been identified under the no-action alternative.

### 4.2.7 Ecological Resources

No impacts to ecological resources have been identified for the no-action alternative.

#### 4.2.7.1 Threatened or Endangered Species

As noted previously, the beaches adjacent to the BONUS facility provide potential nesting habitat for the endangered hawksbill sea turtle and leatherback sea turtle, and the endangered plant *Buxus vahlii* is known to grow on the BONUS property. Under the no-action alternative, no direct impacts to these species would occur.

### 4.2.8 Historical, Cultural and Archaeological Resources

No adverse impacts to historical, cultural or archeological resources would occur under the no-action alternative. However, since the BONUS facility would not be developed as a museum under this alternative, fewer maintenance and preservation activities for this facility may be performed relative to the proposed action and action alternatives.

### 4.2.9 Noise

No noise impacts would occur under the no-action alternative.

### 4.2.10 Transportation

No transportation impacts would occur under the no-action alternative.

### 4.2.11 Human Health and Safety

No detrimental impacts to human health and safety have been identified under the no-action alternative. Monitoring and surveillance of the BONUS facility would continue to ensure that no radiation exposures in excess of applicable radiological protection standards would occur and no unacceptable physical or chemical hazards occur.

#### 4.2.11.1 Radiological Exposure

The potential radiation dose to a hypothetical surveillance and maintenance worker under this alternative would be equivalent to the worker in Section 4.1.11.1, with the exception of differences in the exposure frequency and duration assumptions. In the ALARA analysis conducted for the facility (Jacobs 1998c), it was assumed that two hypothetical surveillance and maintenance workers would enter all areas of the building one day per year for general surveillance activities and would receive an estimated dose of 0.2 mrem/year each. A larger group of 4 workers would occupy the building for one week every other year for maintenance activities and would receive an estimated dose of 1 mrem/year each. The calculated collective dose is 0.026 person-rem for all maintenance workers over a 10-year period (Jacobs 1998c). This calculation conservatively neglects reduction of the source term through radioactive decay over this period.

Based on the DOE ALARA cost guidance (DOE 1997) for optimization analyses, the justifiable expenditure to reduce this dose background levels is insufficient to accomplish any meaningful dose reductions. On this basis, the estimated doses under the current conditions were determined to be ALARA (Jacobs 1998c).

#### 4.2.11.2 Occupational Safety and Health

No adverse impacts to occupational safety and health have been identified under the no-action alternative. Workers engaged in surveillance and maintenance activities at the facility would be required to follow requirements of 10 CFR 835 for radiation protection, as well as applicable requirements of OSHA regulations. With the exception of the residual radioactive materials in the entombed monolith, most hazards associated with the BONUS facility are similar to routine industrial hazards at any large inactive facility and can be readily mitigated.

#### 4.2.11.3 Accidents

No accident impacts have been identified under the no-action alternative. No radioactive or hazardous materials at the facility would be available for release under plausible accident scenarios. Accidents associated with routine physical and industrial hazards at the facility are similar to those found at any inactive industrial complex.

## 4.3 AUTHORIZING PREPA TO GRANT PUBLIC ACCESS TO THE BONUS REACTOR BUILDING FOLLOWING ADDITIONAL DECONTAMINATION

Activities under this alternative would include additional decontamination of areas of elevated concentrations of residual radioactive materials within the BONUS reactor building. Since previous decommissioning activities are thought to have removed most easily removable contamination, additional decontamination may require aggressive methods, including scabbling of contaminated concrete surfaces. Workers entering controlled areas would be subject to the regulatory requirements of 10 CFR 835, and appropriate measures would be taken to control the spread of contamination and limit worker doses to acceptable levels. Since an inventory of contaminants would remain within the entombed reactor and its associated piping following decontamination, the facility still would not be available for unrestricted use, and continued monitoring and surveillance of the facility would be required.

Following completion of decontamination operations, PREPA would be authorized to allow public access to a museum to be developed at the BONUS facility. The proposed museum would be located within the existing reactor building. Administrative and engineering controls would be implemented and maintained to limit public access to the entombed monolith, to reduce the potential for radiation exposure of museum visitors to acceptable levels.

### 4.3.1 Demography & Socioeconomics

This alternative would be expected to have positive socioeconomic impacts both in the short-term and long-term. Short-term impacts would include increased employment during the decontamination of the BONUS facility. Following completion of decontamination operations, longer-term impacts would include employment of approximately 9 museum staff (assumed to include 4 tour guides, 1 maintenance worker, 1 secretary, 1 museum curator, 1 administrator, and 1 accountant) and 3 shift guards, and also increased tourism revenues from museum visitors. The facility still would not be suitable for unrestricted use, and controls would still be required to restrict access to the entombed monolith.

#### 4.3.1.1 Environmental Justice

No high and adverse impacts have been identified which would disproportionately affect any minority group or low-income population under this alternative.

### 4.3.2 Land Use

Implementation of this alternative would create no negative impacts on land use at the BONUS reactor site. The currently inactive BONUS facility would be operated as a museum for the public benefit. Surrounding land use would be not be impacted.

### 4.3.3 Geology and Soils

No impacts to geology and soils have been identified. All activities under this alternative would take place within the existing reactor building.

### 4.3.4 Air Quality

Negligible impacts to air quality have been identified under this alternative. There would be minor short-term impacts due to increased vehicular traffic and operation of equipment during the decontamination operations. In the longer term, any increase in vehicular traffic and vehicle exhaust emissions would be expected to have negligible impact on local air quality.

### 4.3.5 Hydrology and Water Quality

No impacts to hydrology and water quality have been identified. Under this alternative, there would be no planned releases to surface water or groundwater.

### 4.3.6 Floodplain/Wetlands

No impacts to floodplains or wetlands have been identified under this alternative. The BONUS site does not lie within the 100-year floodplain of any surface water body, and no wetlands have been identified at the site. All operations would be conducted within the existing BONUS reactor building. No construction or demolition of structures or alteration of terrain would be required in implementing this alternative.

### 4.3.7 Ecological Resources

No impacts to ecological resources have been identified for this alternative. All operations would be conducted within the existing BONUS reactor building.

#### 4.3.7.1 Threatened or Endangered Species

As noted previously, the beaches adjacent to the BONUS facility provide potential nesting habitat for the endangered hawksbill sea turtle and leatherback sea turtle, and the endangered plant *Buxus vahlii* is known to grow on the BONUS property. Since all decontamination activities under this alternative would occur in the existing BONUS reactor building, and the proposed action would be entirely within the existing building, potential impacts to these species would not occur.

#### 4.3.8 Historical, Cultural and Archaeological Resources

No adverse impacts to historical, cultural or archaeological resources would occur under this alternative. All activities would be conducted within the existing BONUS reactor building. Development of a museum at the BONUS facility may result in improved protection (e.g., maintenance and upkeep) of this facility.

#### 4.3.9 Noise

Negligible noise impacts have been identified for this alternative. Short-term impacts associated with the decontamination operations within the BONUS facility would be constrained to legal requirements and mitigative measures would be implemented. Increases in vehicular traffic associated with the new museum would be expected to have a negligible impact on noise over the longer term. Transportation vehicles would meet legal requirements for exhaust noise suppression.

#### 4.3.10 Transportation

Negligible transportation impacts have been identified. There would be a short-term increase in automotive traffic by construction workers during decontamination operations and shipment of the waste off-site. In the longer term, any increase in traffic associated with visitors to the new museum would be expected to have negligible impacts.

#### 4.3.11 Human Health and Safety

No detrimental impacts to human health and safety have been identified under this alternative.

##### 4.3.11.1 Radiological Exposure

Workers engaged in the decontamination operations would be qualified radiation workers subject to occupational radiation protection requirements under 10 CFR 835. Following the decontamination of residual radioactive materials within the BONUS facility, the potential for radiation exposure of the public would be reduced. Since residual radioactive materials above guidelines for unrestricted release specified in DOE Order 5400.5 would remain within the entombment after completion of decontamination operations, monitoring and surveillance programs would be continued to ensure that no unacceptable radiation exposures could occur.

Potential radiation dose to individuals at the facility following completion of decontamination activities under this alternative would be reduced from current levels and restrictions on the facility's use and radiological control measures would be relaxed. However, because an inventory of contaminants will remain within the entombed reactor and its associated piping, the facility would not be entirely available for unrestricted use. Based on exposure rate measurements within the facility, the dose to a hypothetical worker occupying this facility on a full-time basis would be estimated at approximately 20 mrem/year (after additional decontamination), approximately 10 mrem/year above the dose from the background gamma exposure rate alone.

Based on the DOE ALARA cost guidance (DOE 1997) for optimization analyses, the justifiable expenditure to reduce this dose background levels is insufficient to accomplish any meaningful dose reductions. The estimated cost for decontamination greatly exceeds the benefit gained from dose-reduction; therefore, the ALARA analysis concluded that the benefits from additional decontamination of the facility would be outweighed by the costs of performing the actions (Jacobs 1998c).

#### 4.3.11.2 Occupational Safety and Health

No adverse impacts to occupational safety and health have been identified under this alternative. Workers engaged in decontamination operations and subsequent surveillance and maintenance activities at the facility would be subject to the requirements of 10 CFR 835 for radiation protection, as well as applicable requirements of OSHA regulations. With the exception of the residual radioactive materials in the entombed monolith, most hazards associated with the BONUS facility are considered to be routine industrial hazards and can be readily mitigated.

#### 4.3.11.3 Accidents

No accident impacts have been identified under this alternative. No radioactive or hazardous materials at the facility would be available for release under plausible accident scenarios. Accidents associated with routine physical and industrial hazards at the facility are similar to those found at any industrial complex and can be readily mitigated.

## 4.4 CUMULATIVE AND LONG-TERM IMPACTS

Cumulative impacts include effects on the environment that could result from the incremental impacts of the proposed action, when added to other past, present, and reasonably foreseeable future actions. Such impacts could occur from individually minor, but collectively significant actions taking place over a period of time (40 CFR 1508.7).

No cumulative or long-term environmental impacts have been identified for the proposed action nor the reasonable alternatives. Development of the BONUS facility as a museum would not be expected to contribute to impacts from other actions that may be taken in the vicinity.

# 5. AGENCIES & ORGANIZATIONS CONSULTED

During this NEPA evaluation, DOE contacted the U.S. Fish and Wildlife Service to obtain the latest information on threatened and endangered species or designated critical habitats that could occur in the vicinity of the proposed action. Informal consultation with the USFWS was initiated under Section 7 of the Endangered Species Act (16 U.S.C. 1531 et seq.). The USFWS response indicated that the proposed action falls within the range of the endangered hawksbill sea turtle (*Eretmochelys imbricata*) and leatherback sea turtle (*Dermochelys coriacea*), as well as the endangered plant *Buxus vahlii* (FWS 2001a). However, since the scope of the DOE proposed action is limited to authorizing PREPA to allow public access to a proposed museum inside the BONUS reactor building, the USFWS concurred with the DOE determination that the proposed action would not be expected to adversely affect any endangered species or its habitat (FWS 2002). Threatened and endangered species are discussed in Sections 3.7.3 and 4.1.7.1.

DOE is also required under Section 106 of the National Historic Preservation Act to consult with the State Historic Preservation Office regarding the presence of archaeological and historic sites and potential for adverse effects at the site of the proposed action. DOE consultation with the U.S. Advisory Council on Historic Preservation determined that no formal consultation with the SHPO would be required for this proposed action (DOE 2001), and that the proposed action would be considered beneficial to the preservation of historical and cultural resources. Cultural resources are discussed in Sections 3.8 and 4.1.8.

DOE activities at the BONUS facility are required to operate in accordance with environmental regulations established by federal and state laws, executive orders, and DOE directives. Relevant DOE orders include DOE Order 5400.1, *General Environmental Protection Program*, and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. Regulations implementing the Clean Air Act, Clean Water Act, NRC rules, Resource Conservation and Recovery Act, Safe Drinking Water Act, Toxic Substances Control Act, Emergency Planning and Community Right-to-Know Act, and others may apply.

The following agencies were contacted for information and data used in the preparation of this EA.

Puerto Rico Department of Health
P.O. Box 70184
San Juan, Puerto Rico 00936-8184

U.S. Advisory Council on Historic Preservation
1100 Pennsylvania Avenue, NW
Washington, DC 2004

U.S. Department of the Interior

Fish and Wildlife Service
Boqueron Field Office
P. O. Box 491
Boqueron, Puerto Rico 00622

# 6. REFERENCES


AEC (U.S. Atomic Energy Commission), 1974, *U.S. Atomic Energy Commission Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors*.

ANL (Argonne National Laboratory), 1993, *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0,* ANL/EAD/LD-2, Argonne, Illinois, USA.

ANL (Argonne National Laboratory), 1994, *RESRAD-BUILD: A Computer Model for Analyzing the Radiological Doses Resulting from the Remediation and Occupancy of Buildings Contaminated with Radioactive Material,* ANL/EAD/LD-3, Argonne, Illinois, USA.

Auxier and Associates, Inc., 1997, *Boiling Superheat Power Station Decommission Final Report (PRWRA 1970-WRA-B-70 500), Phase II Radiological Survey of Materials in the BONUS Reactor*.

Fish and Wildlife Service, 2001a, U.S. Department of the Interior, Fish and Wildlife Service, Boqueron Field Office, Boqueron, Puerto Rico, letter from James P. Oland, FWS, to James L. Elmore, DOE-ORO, *Boiling Water Superheater (BONUS), Rincón, Puerto Rico*, May 21, 2001.

Fish and Wildlife Service, 2001b, U.S. Department of the Interior, Fish and Wildlife Service, Boqueron Field Office, Boqueron, Puerto Rico, letter from Susan R. Silander, FWS, to David R. Allen, DOE-ORO, *Draft EA for Public Access to BONUS Reactor, Rincón, Puerto Rico*, October 29, 2001.

Fish and Wildlife Service, 2002, U.S. Department of the Interior, Fish and Wildlife Service, Boqueron Field Office, Boqueron, Puerto Rico, letter from James P. Oland, FWS, to David R. Allen, DOE-ORO, *Section 7 Consultation Public Access to the Boiling Nuclear Superheat Entombed Reactor Building, Rincón, Puerto Rico,* March 20, 2002.

Fragoso, J.H., 1966, Letter Report to P. Morris and F. Long, Atomic Energy Commission, *Report on Airborne Radioactive Contamination Inside the BONUS Plant Containment Building After Reactor SCRAM of November 1, 1966*, November 2, 1966.

Jacobs Environmental Management (EM) Team, 1998a, *Summary Report for the Radiological Survey of the Boiling Nuclear Superheat (BONUS) Research Reactor, Rincón, Puerto Rico*.

Jacobs Environmental Management (EM) Team, 1998b, *Puerto Rico Electric Power Authority Radiological Control Manual for the BONUS Facility, Rincón, Puerto Rico*.

Jacobs Environmental Management (EM) Team, 1998c, *White Paper for As Low as Reasonably Achievable Analysis of the Boiling Nuclear Superheat Reactor Facility, Rincón, Puerto Rico*.

Puerto Rico Water Resources Authority (PRWRA) and United Nuclear Corporation, 1970, *Boiling Nuclear Superheater Power Station Decommissioning Final Report*, WRA-B-70-500, San Juan, Puerto Rico.

Puerto Rico Seismic Network (PRSN), http://rmsismo.upr.clu.edu/ingles/index.html

Rivera, M.M. and J.A. Bonnet, 1966, Report to J.H. Fragoso, BONUS Plant Superintendent, *Radiation Exposure Incident*, May 20, 1966.

West, J.M. and J.H. Fragoso, 1966, *BONUS Operating Experience*, Presented at American Power Conference, April 26-28, 1966, Chicago, IL.

U.S. Department of Energy, 1990, *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, Washington, D.C., February 8.

U.S. Department of Energy, 1996, *INITATION Phase I: Radiological Survey of Materials and Equipment in the BONUS Reactor*.

U.S. Department of Energy, 1997, DOE Standard, *Applying the ALARA Process for Radiation Protection of the Public and Environment, Compliance with CER Part 834 and DOE 5400.5 ALARA Program Requirements,* DOE-STD-ALARA 1draft, Washington, D.C.

U.S. Department of Energy, 1998, Environmental Justice Strategy, Executive Order 12898

U.S. Department of Energy, 2001, personal communication between Ray Moore, DOE-ORO, and Tom McCullough, Advisory Council.

U.S. Department of Energy, 2002, Letter from David R. Allen, DOE-ORO, to Susan R. Silander, USFWS, *Informal Consultation Under Section 7 of the Endangered Species Act – Draft Environmental Assessment for Authorizing the Puerto Rico Electric Power Authority to Allow Public Access to the Boiling Nuclear Superheat (BONUS) Entombed Reactor Building, Rincón, Puerto Rico,* February 8, 2002.

U.S. Department of Energy and Puerto Rico Electric Power Authority (PREPA), 2001, *Memorandum of Understanding for Department of Energy and Puerto Rico Electric Power Authority (PREPA)*.

U.S. Environmental Protection Agency, 2001, Aerometric Information Retrieval System (AIRS) data base, www.epa.gov/airs/.

# ATTACHMENT A: CONSULTATIONS

# ATTACHMENT B: REVIEW COMMENTS AND DOE RESPONSES

# ATTACHMENT B
# REVIEW COMMENTS AND DOE RESPONSES

The draft EA was distributed for public comment in August 2001, and the public comment period ended on October 17, 2001. Copies of the draft EA were distributed by mail to identified interested parties, and multiple copies were placed in the public library in Rincón. A public notice of availability was published in the local newspapers announcing the availability of the draft EA for review. Public meetings were scheduled to be conducted on September 18, 19, and 20, 2001, in Rincón, but were canceled due to travel restrictions following the tragic events of September 11, 2001.

Comments were received only from the U.S. Department of the Interior, Fish and Wildlife Service, regarding potential impacts of the proposed action on the endangered hawksbill sea turtle (*Eretmochelys imbricata*), the leatherback sea turtle (*Dermochelys coriacea*), and the plant *Buxus vahlii*. The beaches adjacent to the BONUS facility provide potential nesting habitat for the two species of sea turtle. A population of *Buxus vahlii* is present on property owned by PREPA adjacent to the BONUS facility. This plant species is known to exist only on Puerto Rico and St. Croix, and this is one of five known locations on the island of Puerto Rico, and one of the largest populations. DOE responses were transmitted to the Fish and Wildlife Service in a letter dated February 8, 2002. The Fish and Wildlife Service indicated their concurrence with these responses in a letter dated March 20, 2002, indicating that no further consultation was required. This correspondence between DOE and FWS is presented in Attachment A.